THE LIMESTONE INDUSTRY

By KEN BECKER, '38

Conclusion

THE production of limestone is carried on now about entirely by machinery powered by steam and electricity. The efficient machines which have been produced in recent years have greatly replaced the manual labor of earlier times.

After the plan of the quarry has been developed and the ground plot laid out, the first operation, which is usually called stripping, consists in removing the overburden. This is accomplished by the use of mechanical and hydraulic methods; and, in either method, if the overburden is hard and solid, dynamite is usually used to tear down the waste stone. The mechanical method consists in removing the waste by steam shovels, clamshell shovels, and tractor lifts. The steam shovel, which was originally used in making cuts for railroad work, is now used extensively to break the loose earth away from the stone formation. Sometimes clamshell shovels are used if there is a great amount of solid earth to be removed. The last and best piece of apparatus, the tractor lift, is essentially the most efficient of all the machines. This combination of a tractor and a derrick is widely used and very economically operated. The machinery of this contrivance consists of a derrick anchored at one end and controlled at the other end by cables fastened to a caterpillar tractor. The tractor is moved forward or backward to lift or to lower the shovel at the loose end of the cable. The load which this appartus can lift is very great; consequently, it is used extensively where large blocks are removed from the ledges in the quarry.

All these machines which are used in the machine method of removing the overburden are essential in a successful quarry plan. These machines have two principal functions: they loose, the solid masses of shale and impure limestone, and the lift, with the use of the shovel, dumps the waste in the proper place.

By the use of the hydraulic method, a much cleaner job of stripping can be accomplished. In this process of removing the waste, the earth is washed away by water, driven through a specially-constructed nozzle under high pressure. It has been proved that the hydraulic method is more successful than the mechanical method where the overburden consists of a loose mantle of earth. The apparatus is simply a long hose on the end of which is fastened a long narrow-necked nozzle supported on a movable steel tripod. Water, under high pressure, is forced through the nozzle onto the overburden and the waste is gathered into huge piles in a suitable section of the quarry. Where the overburden consists of both earth and rock, a combination of hydraulic excavating and drilling and blasting away the waste rock is employed. When the waste stone or overburden has been torn loose from the ledges, it is either hauled away or used as material for rock crushers.

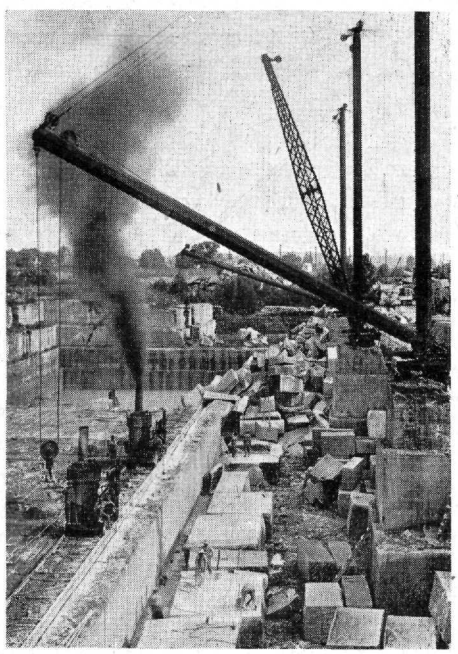
After the limestone ledges have been uncovered, the first essential quarry operation consists in obtaining the rough slabs of stone from the quarry. In a quarry plan, there are two methods of extracting the stone from a formation: by open surface quarrying and by underground mining. The open surface method is more prevalent and more widely used than the mining project.

The open surface method is always used when the overburden is shallow and can be removed without excessive cost. The equipment is set up in the quarry on the surface of the formation and the operations are performed on top of the ledges. Channeling machines drill holes in the ledges and the blocks are forced from the walls by the use of wedges in these holes. Then the huge blocks are removed to the railroad cars by a system of derricks and cable guides. The advantages of an open surface quarry are: no artificial means of ventilation is required, there is no danger of falling rock, no danger of an explosion, skillful labor is not required, and a cleaner block of limestone is obtained.

The underground mining project, which is essentially an excavating operation, is used where the overburden cannot be removed without excessive expenditure. In a limestone mine, the quarry is enclosed by the ground and is located in the strata in such a position that a large roof of limestone overlies the pit from which the limestone is removed. This roof which holds the deep overburden away from the pit is the ceiling of the cavity in the side of the strata. Chaneling machines are set up in the under-

QUARRYING THE STONE

Courtesy Indiana Limestone Co.



ground room and are used to drill holes in the ledges so that wedges may be used to force the stone from the formation. Dynamite is seldom used to break the stone away, because there is danger of dislodging pieces of material and injuring the workers. After the stone is removed from the pits, small railroad cars transport the blocks to the outside of the mine. At the opening of the mine, derricks load the blocks onto the flat railroad cars which haul the stone to the mill. The advantages of underground mining are: the removal of large masses of overburden is avoided, the mine may be operated the year round irrespective of weather conditions, storage facilities are furnished underground without deterioration to the product, the block of stone can be kept clean in a mine, and the mine can be worked to the property line without infringing on adjacent property.

In the open surface quarry and the underground mine, the equipment is set up in the most advantageous position. The most important types of equipment for these methods are derricks, channeling machines, and gas engines. The derrick is a hoisting apparatus which employs a tackle placed at the end of a beam. All of the steam and electrically driven derricks are used to remove the stone from the ledges of the railroad cars. The channeling machine is used to remove the blocks of stone from the ledge. These machines are constructed in such a way that they sink channel grooves into the ledge. The machines cut a groove about two inches in width to a depth of from eight to twelve feet. All these grooves are customarily spaced slightly over four feet apart and are slightly over four feet apart when a special piece of stone is required. Then a series of holes are drilled into the ledge of stone about six inches apart opposite the base of the channel cut and steel wedges are driven into these holes. The cut is laid over on its side by the use of wire ropes and pulleys connected to the fall line of the derrick. These cuts of stone usually around four feet in width and twelve feet in depth have a length of from forty to sixty feet, but sometimes have a length of from eighty to a hundred feet, and weigh hundreds of tons. The next operation of this machine is to drill and split these huge cuts into mill blocks for convenient transportation and handling in the fabricating plants. The usual size for these mill blocks is around twelve feet in length, four feet in width and three feet in depth. One of the most essential pieces of apparatus in the quarry is the gas engine air compressor. The air compressor is a machine fitted with a cylinder and piston which compresses the air and sends it to the air hammers and air drills. It is a simple machine, but is indispensable to the modern quarry.

In the plan of a quarry, it is important to decide the nature of the formation and then to choose the open surface method or the underground mining method for the process of quarrying. It is very essential to consider the advantages and disadvantages in each project. In the open surface project, the removal of the overburden is the most important problem; in the underground mining project, the most important problem is to find a suitable location in the side of the formation to hollow out a place for the mine. These two processes of quarrying are fundamental in working out an efficient quarry plan. The advantages and disadvantages of the method which is chosen for any quarry plan should be carefully considered in relation to the advantages and disadvantages of the alternative method. If this plan of quarry development is adhered to, excessive expenditure and needless work can be avoided.

The mill system of a limestone company includes the drafting room and the mill operators. The function of the drafting room is to furnish the description and dimensions of the stone through a system of block cards. The exact size and shape of the stone are printed on these block cards and they are kept with the block throughout the milling process. The work of the mill operator is to cut the stone to the specifications laid down by the drafting room. The superintendent of the mill checks on both the drafting room and the mill operator, by verifying the dimensions of the blocks and the dimensions on the block card. All pieces of stone are required to have a final check before they are shipped to their destination.

The character of different limestone is an important factor to consider in the milling process. The strength, variety, grain and texture are the most important items to study, in order to work out a systematic mill plan. Each of these factors is important because it is involved in all the cutting processes. Limestone, as compared to marble or granite, is very elastic and much easier to fabricate. The elasticity of limestone, is often referred to as the strength of the stone. The varieties of limestone vary from white, through tones of yellow to brown or from various shades of gray, dove-color, bluish grays, dark gray to black. Reddish colors are very rare. The yellow and brown colors are due to iron oxide, the gray and black, which are most common, to organic matter. Limestone is fine grained to very dense in texture. The strength of the formation varies very much with the texture; firm compact varieties are very stable, loose porous ones are very weak. In general, the variety of limestone depends upon the circumstances, especially the mode of formation. In some formations there are abundant remains of fossils which may give the rock a distinctive feature. On the other hand, there are varities which depend upon the presence of some impurity for their particular character.

In the fabrication of limestone in the mill, various machine processes are employed. The first milling operation consists in sawing the rough blocks of stone into slabs of various thicknesses by gang saws. These gang saws consist of a series of saw blades about thirty feet long, mounted on a reciprocating frame which works back and forth across the surface of the stone and cuts the block into sections. Slush ways are erected on each side of the saw to catch the sand and water which is used as an abrasive mixture. An efficient gang saw is capable of sawing around 30,000 feet of stone per month. The texture and grain of the stone are the most important factors that affect gang saw production. In Texas, where the texture of the limestone is not so fine as it is in other districts, the gang saw

production reaches as high as 47,000 feet of stone per month. In other districts, where the texture of the stone is very fine, the production may not reach 30,000 feet per month.

After the gang saws have cut the blocks into rough slabs, diamond saws are used to cut the slabs into different widths. A diamond saw is a machine which has a circular blade of steel about five feet in diameter with diamond set teeth. These teeth are true diamonds, but they are not transparent and consequently have no value as jewels. These black diamonds, as they are called, which are of the hardest substance known, cut through the blocks with great ease. The blocks and slabs as they come from the saws show slightly the mark of the saw teeth, and these are either mechanically rubbed or hand dressed.

In the finishing process, planers and lathes are used to produce the various details in the stone. The planer is the most common type of finishing machine and is used to reproduce the simpler architectural forms, such as blocks, sills, lintels, mouldings, and columns. These planers are machines which consist of a cutting crane located over a movable car. After the stone is placed on the car, the crane, which holds the differently shaped tools, slides across the stone and smooths the surface. The planer is simple in construction, but is one of the most important machines in the mill.

The lathe is a machine by which the pieces of stone are held and rotated while being tool dressed. This piece of apparatus is used to reproduce the circular designs in the block of stone. By the means of a lathe, columns, fifty feet long with a diameter of from six to eight feet, are turned out accurately. In general, the planers and lathes are used to reproduce the last machined effects in the stone.

After the planing and lathe-work, if the specifications call for carving, the stone is conveyed to the carving department where the final milling operation is made. The preliminary processes of the carving on a piece of stone are carried out for some time before the block reaches the department. First, a clay model is made of the piece of stone. Then, the clay model is processed and a plaster of Paris cast is made from it. These casts are very delicate and expensive, and, as is usually the case, the contractor remunerates the carver for each model made of the stone. After the plaster of Paris cast of the carved piece is made, the image or design is carved in the stone. The most widely used tool in the carving process is the pneumatic hammer. These hammers are tools which are held against the stone and when the tool is vibrated by the use of compressed air, the bits of stone are chipped off. The two important methods of carving are the Scottish and Italian. In both processes, the air hammers are used, but in the Scottish method the stone is rough hewn and the surface of the block shows the marks of the hammer. In the Italian method, the stone is not rough hewn, but is carved so smooth that it appears polished. However, either method of carving shows a product of excellent workmanship, and the choice of the rough hewn or the polished surface methods is made by preference.

After the carving process, the stone is polished by sand blasting or by sand washing. The sand washing is preferable, especially where the stone is to be exposed to the weather. By this process, many harmful impurities are removed from the crevices before the stone is placed in the building. Also, after a wetting process, the stone is toughened by exposure to air.

When the stone is ready for shipment, a final inspection is made. The block cards and the drafting cards are compared and the dimensions of the stone are checked. Then, the stone is properly blocked in a railroad car and is sent to its destination.

The production of limestone includes both the quarrying and fabrication of the stone, and since most of the fabrication is usually done near the building site, fabricating plants are located in all the important towns and cities. As a result, improvement in the industry would result in improvement of business areas. The industry is relatively young, but it has been proved that limestone is gradually replacing all other types of building materials and is being called the nation's building stone.

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Motorists of the future will no longer refer to their brand of fuel as having a high octane rating. For in the future it is believed that most automobiles will be Diesel-powered, and this type of engine burns fuel oil. The quality of this oil is determined by its centene number, which is its ability to burn quickly.

Experiments show that radium rays effect a breakdown and final death in living cells of all animals, and never stimulate a more active growth.

The world's second largest stony meteorite has lately been found in Kansas. Its weight is 700 pounds.